

REMARKS

The Office Action mailed on 04/23/10 rejected pending Claims 1-32. Claim 21 has been amended. No claims are canceled or deleted.

In response to the previous mailed Office Action of 08/12/09, Applicants responded and provided arguments and/or amendments to overcome those rejections. Specifically, Claims 1-4 and 7-27 were rejected under 35 USC 102(b) as anticipated by Torimoto et al in U.S. Pat. No. 7,381,465, and Claims 1-4, 7-12 and 16-21 were rejected as obvious under 35 USC 103(a) over Luo et al, and separately Torimoto et al. As the present Office Action mailed 04/23/10 makes no mention and does not reiterate the rejections made in the previous Office action, Applicants assume that the rejections previously made in the Office action of 08/12/09 have been overcome and were withdrawn. Applicants respectfully request the Examiner to confirm on the record that the previous rejections have been withdrawn.

Applicants address the rejections in the Office Action mailed 04/23/10 in the order they were provided.

I. Priority

The Office Action mailed 4/23/10 states on page 2 that the disclosure of the prior filed Provisional Application No. 60/555,590, for which this application claims priority, allegedly fails to provide adequate support or enablement in the manner provided by 35 U.S.C. 112, 1st paragraph, for one or more claims in the current application.

Applicants respectfully point to MPEP § 2163.02 which states regarding compliance with the written description requirement, “[T]he fundamental factual inquiry is whether the specification conveys with reasonable clarity to those skilled in the art that, as of the filing date sought, applicant was in possession of the invention as now claimed.” MPEP § 2163.02 further states, “Possession may be shown in a variety of ways including description of an actual reduction to practice....”

In Provisional Application No. 60/555,590, Applicants describe several actual reductions to practice of the invention. In an example of one such description of an actual reduction to practice, on page 4 of the specification of the provisional application, Applicants describe,

Sulfidation of cobalt was the first case where we observed hollow nanostructures. Cobalt sulfide hollow nanospheres are synthesized in one pot by immediate injection of a solution of sulfur in *o*-dichlorobenzene into a hot Co nanocrystal dispersion (as shown in the transmission electron microscopy (TEM) image in Fig. 1A) that is prepared by literature methods (15, 19). At 445 K, the reaction between cobalt and sulfur completes within a few seconds, resulting in a stable black solution of cobalt sulfide nanocrystals. We have confirmed that hollow particles are produced at temperatures as low as 373 K.

On the following pages, among other things, Applicants explain that they synthesized nanoreactors by sulfidation of cobalt, and by reaction with selenium. Applicants also describe the methods, results of the reactions, and properties of the nanoreactors that were obtained.

Applicants also describe several reductions to practice of the invention on pages 13-14 of the specification under the heading "Captions to Figures." In several examples of such descriptions of actual reductions to practice, on page 13 of the specification of the provisional application, Applicants describe,

Fig. 1. (A) TEM image of Co nanocrystals synthesized by injecting 0.54 g of $\text{Co}_2(\text{CO})_8$ in 3 ml of *o*-dichlorobenzene into 0.1 ml of oleic acid and 0.1 g of trioctylphosphine oxide in 15 ml of *o*-dichlorobenzene at 455 K. (B, D) TEM images of the cobalt sulfide phases synthesized by injecting sulfur in *o*-dichlorobenzene (5 ml) into cobalt nanocrystal solution with different Co/S molar ratios: (B) Co_3S_4 with Co:S=9:12 and (D) Co_9S_8 with Co:S=9:8. The Co_3S_4 particles were synthesized from the Co sample shown in (A), while the Co_9S_8 particles started from another Co sample which has an average diameter around 11 nm. (C) HRTEM images of Co_3S_4 (left) and Co_9S_8 (right). (E) XRD patterns of cobalt nanocrystals (a) and cobalt sulfide synthesized with different Co/S molar ratios: (b) 9:5; (c) 9:7; (d) 9:8; (e) 9:10; (f) 9:11; (g) 9:12; and (h) 9:18.

Fig. 2. Evolution of CoO hollow nanocrystals with time by blowing a stream of O_2/Ar (1:4 in volume ratio, 120 ml/min) mixture through a cobalt colloidal solution at 455 K. (A-D) TEM images of the solutions after flowing O_2/Ar for (A) 0 min; (B) 30 min; (C) 80 min; (D) 210 min. The inset shows a HRTEM of a CoO hollow nanocrystal. (E) XRD patterns of the sample obtained from the solution after flow O_2/Ar for (a) 0 min; (b) 2.5 min; (c) 5.5 min; (d) 10 min; (e) 30 min; (f) 80 min; and (g) 210 min.

Fig. 3. Evolution of CoSe hollow nanocrystals with time by injection of a suspension of selenium in *o*-dichlorobenzene into a cobalt nanocrystal solution at 455 K, from top-left to bottom-right: 0 sec, 10 sec, 20 sec, 1 min, 2 min and 30 min. The Co/Se molar ratio is 1:1.

Each description and/or its accompanying figure would allow one skilled in the art to recognize that Applicants were in possession of the claimed invention.

Furthermore, in Vas-Cath, Inc. v. Mahurkar the Court of Appeals for the Federal Circuit held that figures alone are sufficient to provide support in the manner required by the first

paragraph of 35 U.S.C. 112. 935 F.2d 1555, 1563-64 (Fed. Cir. 1991). In that case, the applicant filed a design application with the PTO consisting of figures only. The applicant then later filed utility applications claiming priority to the design application. The court stated that “drawings alone may be sufficient to provide the ‘written description of the invention’ required by §112, first paragraph” and held that the utility patents could properly claim priority to the design application even though there was no textual support for the invention in the design application. Id. at 1564.

Here, Applicants have gone above and beyond the Vas-Cath standard. Provisional Application No. 60/555,590 contains both figures and textual support which demonstrate that Applicants had possession of the claimed invention as of the filing date of the provisional application.

The rejection on page 2 of the Office Action mailed 4/23/10 alleges that there is no support for language in the claims regarding the shell thickness of the nanocrystals. Applicants disagree and respectfully point to the figures provided in the provisional application, which show several examples of actual reductions to practice of nanocrystals having shell thicknesses between 0.5nm to 100nm. In Figure 2, the insert image in the center of Figures 2a-2d shows a High-Resolution Transmission Electron Microscopy image of one actual reduction to practice of a CoO hollow nanocrystal. The bottom of the insert displays the scale of the image, which is represented by a horizontal bar indicating the relative length in the image of 5nm. The hollow core of the nanocrystal is visible as is the thickness of the shell. Judging by the scale of the image, one skilled in the art will see that the thickness of the nanocrystal shell falls between 0.5nm and 100nm.

Figure 3 shows the evolution of CoSe hollow nanocrystals with time by injection of a suspension of selenium in *o*-dichlorobenzene into a cobalt nanocrystal solution at 455 K. The scale of each frame is indicated by a horizontal bar indicating the relative length in the image of 20nm. Judging by the scale of the image, one skilled in the art will see that the thickness of the nanocrystal shell falls between 0.5nm and 100nm.

Moreover, MPEP § 2163.02 states, “The subject matter of the claim need not be described literally (i.e., using the same terms or *in haec verba*) in order for the disclosure to satisfy the description requirement.” Thus, the need to provide verbatim support for each and every term in the claims would be unnecessary. Furthermore, Applicants respectfully point out

that the Examiner was not able to or in any case, did not identify which particular claims, if any, are not entitled to the priority date of Provisional Application No. 60/555,590. Applicants believe that the arguments above show that there is more than adequate support in the provisional application for Claims 1-32 and priority is proper.. Therefore, in light of the foregoing, Applicants respectfully request that this rejection be withdrawn.

II. Claim Rejections – 35 USC § 112

On pages 3-4 of the Office Action mailed 4/23/10, claims 1 and 21 were rejected for allegedly failing to comply with the written description requirement of 35 U.S.C. 112 because Examiner was unable to locate support in the specification for language discerning “not comprised of discrete molecular sheets” in relation to the structure of the hollow nanocrystal. For the reasons stated above in the previous section, Applicants respectfully point out that there is no need to provide verbatim support for each and every term in the claims.

Furthermore, on page 7 of the specification of the non-provisional application, Applicants describe (emphasis added),

It is understood that in accordance with this invention the shell of the hollow nanocrystals **form a continuous three dimensional domain adopting a three dimensional arrangement of atoms in contrast to molecular sheets** such as found in graphitic, WS₂ or MoS₂ nanotubes and nanocages.

The crystallinity of the hollow nanocrystal wall, or shell is controllable. In a preferred embodiment the shell is at least **partially crystalline**. The advantage of a **polycrystalline shell** is that the defective grain boundary will allow gasses and other chemical species made of small molecules to permeate. One skilled in the art will appreciate that annealing at relatively high temperatures will eliminate many grain boundaries. In one embodiment of the present invention the hollow nanocrystals have an extremely low crystallinity, so as to be almost amorphous. **The hollow nanocrystals in the present invention are not perfectly single crystalline.**

On page 14 of the specification, Applicants also describe (emphasis added),

...various carbon nanostructures, including diamond nanoparticles or carbon nanotubes may be utilized as the starting material and reacted with other species to obtain carbon-alloyed hollow nanostructures, for example hollow nanospheres of steel may be synthesized by reacting a diamond nanospheres with a suitable iron source. This resulting structure will be **chemically and crystallographically very different from sheet-like structures** such as buckminsterfullerenes or carbon nanotubes.

One skilled in the art will understand that these descriptions in the specification refer to the term and provide support for the term “not comprised of discrete molecular sheets” as written in the claims. Thus, because Applicants have shown that there is adequate support under 35 U.S.C. 112 in the specification for the term “not comprised of discrete molecular sheets”, Applicants respectfully request that the rejection be withdrawn.

III. Claim Rejections – 35 USC § 102

A. Rejection under 35 U.S.C. 102(f)

On page 4 of the Office Action mailed 4/23/10, claims 1-32 were rejected because three authors from the publication entitled “Formation of Hollow Nanocrystals Through the Nanoscale Kirkendall Effect” were not listed as inventors of the currently claimed invention. The Office Action alleges that Provisional Application No. 60/555,590 is based upon the above-mentioned publication.

Applicants respectfully point to MPEP § 2137, which reads (emphasis added),
Where there is a published article identifying the authorship (MPEP § 715.01(c)) ... that discloses subject matter being claimed in an application undergoing examination, the designation of authorship or inventorship **does not raise a presumption of inventorship ... so as to justify a rejection under 35 U.S.C. 102(f)**.

Furthermore MPEP § 2137.01 reads, “The party or parties executing an oath or declaration under 37 C.F.R. 1.63 are presumed to be the inventors.” Thus, Applicants, who have filed a Declaration under 37 C.F.R. 1.63, are the rightful inventors.

While in no way constituting any concession and solely in the interest of Applicants’ patent goals, Applicants also submit a Declaration under 37 C.F.R. 1.131 that Applicants conceived or invented the subject matter of this application which is disclosed in the cited publication.

B. Rejection under 35 U.S.C. 102(b)

On page 5 of the Office Action mailed 4/23/10, claims 1-3 were rejected for being allegedly anticipated by Caruso et al.

Applicants respectfully submit that the structures of Applicants’ nanocrystals are made differently than Caruso et al. Caruso et al. disclose the fabrication of hollow nanocrystals by first creating a core, creating a nanoshell around the core, then removing the core (Caruso, 1111). Applicants, on the other hand, teach a method of producing nanocrystals whereby the shell of

hollow nanocrystals is made in a single step without additional material removal steps, and wherein said hollow nanocrystal shell enveloping an empty void or multiple voids.

Furthermore, Caruso et al. discloses the fabrication of nanocrystals with shells of linear polymers which Caruso et al. state creates “regular uniform multilayers” (Caruso, 1111). The multilayers, or discrete molecular sheets, are layered several times on each other to form the nanoshell. Applicants, on the other hand, teach nanocrystals that can contain grain boundaries and other defects in the nanoshell. Applicants teach the use of a polycrystalline material for the nanoshell and the use of grain boundaries in the nanoshell to allow gasses and other small molecules to permeate. Unlike Caruso et al., Applicants claim a hollow nanocrystal that does not contain discrete molecular sheets. Applicants also claim a method involving a single step reaction to create hollow nanocrystals without nanoshell sheet-layering or nanocrystal core removal steps. Nowhere do Caruso et al. mention any of these claimed features of Applicants’ invention.

Because Applicants believe that Caruso et al. do not anticipate the claimed invention, Applicants respectfully request that the rejection be withdrawn.

C. Rejection under 35 U.S.C. 102(e)

On page 5 of the Office Action mailed 4/23/10, claims 1-32 were rejected for being allegedly anticipated by Chow (US Pg Pub. 2006/0279905).

Applicants respectfully point out that Chow was filed on 8/21/06. Applicants claim priority to Provisional Application No. 60/555,590 filed on 3/22/04 and PCT Application PCT/US04/33581 filed on 10/12/04. For the reasons stated above in Section I, Applicants believe that priority to the provisional application is proper. Thus, because both the provisional application and the PCT application antedate Chow, Applicants respectfully request that the rejection be withdrawn.

IV. Double Patenting

While in no way constituting any concession and solely in the interest of Applicants’ patent goals, Applicants submit a Terminal Disclaimer under 37 CFR 1.321(c).

CONCLUSION

Applicants believe that the claims are allowable and request that all rejections be withdrawn. A petition for a two-month extension of time is hereby attached and requested. The Office is authorized to deduct \$245.00 from Deposit Account No. 120690. Please charge any necessary and additional fees that may be due to Deposit Account No. 120690.

For the reasons set forth above, Applicants respectfully request allowance of the pending claims. Should the Examiner believe that a telephone interview would aid in the prosecution of this application, Applicants encourage the Examiner to call the undersigned at (510) 495-2456.

Respectfully submitted,

Dated September 22, 2010

BY: /Michelle Chew Wong/
Michelle Chew Wong
Reg. No. 50,456
(510) 495-2456

Lawrence Berkeley National Laboratory
One Cyclotron Road, Mail Stop 56A-120
Berkeley, California 94720
Telephone (510) 486-7058
Facsimile (510) 486-7896